REMARKS/ARGUMENTS

Reconsideration of this application is respectfully requested in view of the foregoing amendments and discussion presented herein.

1. Rejection of Claims under 35 U.S.C. 112, first paragraph.

The Examiner rejected Claims 23, 50 and 76 under 35 U.S.C. 112, first paragraph, for the stated reason that "The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention." The Examiner further stated that "Applicant has not shown where in the specification teaching of the aspect ratio of the etched portion of said wafer to that of said etched pattern is substantially greater than one."

The Applicant responds as follows:

The first paragraph of 35 U.S.C. 112 states, "The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention."

The Applicant has carefully considered the basis of the Examiner's rejection and has amended Claims 23, 50, and 76. Those claims, as currently amended, include the elements " wherein said etched portion of said wafer has an aspect ratio substantially greater than one; and

wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern." These amended claims are fully supported by the specification, and the specification uses full, clear and concise terms to enable any person skilled in the art to make or use the invention as explained below.

The high aspect ratio particle track etching is first described on page 5, lines 4-7 of the specification as follows:

> "The high aspect ratio nano-machining capability of a particle track etching method that employs a highly enhanced etching rate along particle tracks, which is analogous to machining by a drill bit of a nanometer sized diameter."

The Applicant further states on page 6, lines 10-13 of the specification:

> "The etch rate along the particle tracks can be more than one-thousand times faster than the etch rate of materials not within the immediate vicinity of the particle tracks. The etched particle track area may have a diameter as small as 5 nm and a length as long as many thousand nm along the direction(s) of the particle tracks..."

More particularly, The Applicant states on page 9, lines 15-21:

> "While bond strengths between atoms in a solid are typically on the order of 5 eV, the particle beam energy is preferably much higher. In general, the requirement is a sufficient number of ion pairs per unit track length that the ions will penetrate the wafer to the desired depth and preferably all of the way through the wafer. It will be appreciated that mass and particle charge will affect penetration depth. For example, for substrates that are a few microns thick, the energy should be at least approximately 0.5 MeV to approximately 2.5 MeV per nucleon for ions between argon and krypton." (emphasis added).

The Applicant further states on page 10, lines 8-11:

> "The density of the particle tracks, as well as the etching solution and etching conditions, can be controlled to make the tracks essentially collapse during etching or form isolated holes. This allows deep etching of very small areas (e.g., as small as 5 nm in diameter) with near vertical walls." (emphasis added).

To illustrate an example from the Applicant's disclosure, a wafer of one micron depth is selected as representative of a substrate in the range a few microns thick. The wafer is irradiated with a high energy particle beam to provide complete particle track penetration. An etching pattern with a diameter of about 100 nm is selected as representative of a small area (as small as 5 nm) for etching the exposed particle tracks. This procedure will result in a nanostructure with an aspect ratio of 1,000 nm (1

micron) etch depth, compared to a 100 nm pattern width, or an aspect ratio of 10. In this example, an aspect ratio of 10 is substantially greater than 1 and is derived directly from the precise and exact terms as disclosed in the specification to one skilled in the relevant art.

In view of the claim amendments and discussion above, the Applicant respectfully submits that the grounds for rejection have been sufficiently addressed and overcome, and respectfully requests reconsideration and withdrawal of these grounds for rejection.

2. Rejection of Claims under 35 U.S.C. 112, second paragraph.

The Examiner rejected Claims 23, 50 and 76 under 35 U.S.C. 112, second paragraph, for the stated reasons that,

> "Claims 23, 50, 76 are vague and indefinite because applicant has not explained what part of the etched portion is being comparing to that of the etched pattern. The width, area, or depth? It is unclear how to compare the ratio of an etched portion to an etch pattern when the etched portion would correspondent to or depend on whatever the etched pattern is and appears to be the same as the pattern. At this time, the etch portion would be understood as to be the same as that of the etched pattern."

The Applicant responds as follows:

The second paragraph of 35 U.S.C. states, "The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention."

The Applicant has carefully considered the basis of the Examiner's rejection, and has amended the last elements of Claims 23, 50 and 76 to more particularly and distinctly recite: "wherein said etched portion of said wafer has an aspect ratio substantially greater than one; and

wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern." Support for the subject matter of the amended claims is provided in subsection 1 supra.

In view of the amendment above, The Applicant submits that these grounds for rejection have been sufficiently addressed and overcome, and respectfully requests reconsideration and withdrawal of these grounds for rejection.

3. Rejection of Claims under U.S.C. §102 and §103 - General Comment.

While specific arguments for the rejection of the Claims are provided below, Applicant respectfully submits that the Examiner has misapplied the technology in the cited references to reject the Applicant's claims. The primary cited references, Zandveld, Liu et. al. and Hashimoto use irradiation in the production of a semiconductor device. Two types of irradiation are used; electron beam and particle beam or ion implantation.

In these applications, electron beams are typically used to alter chemical reactivity, such as to make it susceptible to chemical removal. Examples are the patterning for etching in Zandveld (col. 4:25-30) and Hashimoto (col. 2:45-54), or curing in Liu et. al. (col. 6:46-58). The Applicant respectfully submits that electron beams at energy levels of up to 40 keV, as disclosed in the above references, do not form particle tracks in semiconductor device substrates of the reference cites or in desired substrates of the current invention.

Ion beams or particle beams are typically used in a semiconductor process for implantation or doping where a host atom is replaced with one from the ion beam as in Zandveld (col. 4:31-45). Low energy ion beams are also used for altering chemical reactivity as in Zandveld, (col. 3:57-67) and Liu et. al. (col. 6:46-58). In Hashimoto, an ion beam of H^+ is used to change electrical conductivity and eliminate charge up from a subsequent electron beam (col. 2:39-52).

The Applicant respectfully submits that particle tracks, capable of discrete etching guided by the particle tracks, are not formed by irradiation with ion beams with energy in the range of 1 to 320 keV as disclosed in the cited references. In fact, Applicant's work indicates that conventional ion implantation equipment, as used in the semiconductor industry, at best could produce some pitting on the surface of desired

substrates, but does not form particle tracks capable of discrete etching guided by particle tracks as claimed in the present invention.

Therefore, the Applicant respectfully submits that Examiner's general contention that irradiating a wafer with an ion beam of energy levels disclosed in the cited references would not form claimed particle tracks.

4. Rejection of Claims under §102(b) and over Zandveld.

The Examiner rejected Claims 1, 2, 7-11, 16, 18, 23, 28, 29. 34-38, 40, 41, 43, 45, 50, 55, 60, 61, 63, 64, 66, 67, 69, 71, and 76 under 35 U.S.C. § 102(b) as being anticipated by Zandveld (U.S. 4,104,085). Claims 1, 28 and 55 are independent.

In support of the rejection, the Examiner contends that Zandveld discloses the invention as claimed and describes,

> "A method for etching a substrate comprising; bombarding the surface of the wafer having a silicon (di)oxide layer with argon ions having energy of at least 20keV with the depth depending on the ions concentration and energy (claimed irradiating the wafer surface with a charged particle beam of suitable energy) and this would form claimed particle tracks; forming a pattern photoresist on the irradiated wafer surface; etching the wafer with a solution according to the etching pattern (col. 3, line 50-col. 4, line 50; figure 1-5)."

In response, the Applicant has carefully considered the cited reference and the basis of the Examiner's rejection, and has amended independent Claims 1, 28 and 55 to more particularly claim the invention by amending the first element to read, "irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer;" and adding a last element to read "wherein said etching is guided by said particle tracks." The Applicant respectfully submits that Zandveld does not teach the formation of particle tracks capable of discreet etching guided by the particle tracks or the etching guided by particle tracks. Support for this contention is discussed below.

35 U.S.C. §102(b) reads, "A person shall be entitled to a patent unless - (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States."

"To anticipate a claim, the reference must teach every element of the claim." MPEP 2131. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

(a) Zandveld does not expressly teach formation of particle tracks capable of discreet etching or etching guided by particle tracks.

The term particle tracks is not present in Zandveld. There is no mention of formation of particle tracks or etching along particle tracks in Zandveld.

(b) Zandveld does not inherently teach formation of particle tracks capable of discreet etching or etching guided by particle tracks.

"The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic." *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' " *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999).

Zandveld does not teach the inherent formation of particle tracks but instead teaches a treatment that desires a gradation of radiation damage through the substrate to obtain a difference in etching rate. The difference in etching rate desired would be

inconsistent with the formation of particle tracks for etching at a substantially uniform rate along the particle tracks as in The Applicants' invention.

The process in Zandveld starts by irradiating a masking layer of silicon (di)oxide with an ion bombardment. At col. 3:57-61, Zandveld states:

> "This first masking layer is then subjected to a treatment as a result of which the layer 3 shows at its surface a higher etching rate for an etching treatment to be used later in the process than in underlying parts of the layer 3. (emphasis added).

Here, Zandveld teaches a treatment to produce a gradient of etching rates through the substrate as a desired result. This process teaches away from formation of particle tracks capable discrete etching guided by the particle tracks because the presence of these particle tracks would result in substantially uniform etching rates along the particle tracks through the substrate.

Further, col. 3:63-67 of Zandveld set forth:

> "A bombardment with argon ions proves to be very suitable in this respect. In this example, a bombardment with argon ions (arrows 4) with a dose of at least 10^{14} ions per sq. cm and an energy of at least 20 keV and at most 30 keV is used." (emphasis added)

In this step, Zandveld teaches a limited range for the energy level for the ion bombardment to achieve the desired structure damage gradient in the substrate. The energy level for the ion beam in Zandveld is at least an order of magnitude below that of the Applicant's invention. Further:

> "As a result of this, a concentration of at least 10^{19} argon ions per cm^3 with associated structure damage is obtained in the surface layer 3 of the silicon oxide, which is desired to obtain a sufficient difference in etching rate between the surface layer and the remaining part of the oxide layer 3." (emphasis added)

Again, Zandveld teaches a gradient of structure damage through the substrate as the desired result from the ion beam generated within the energy level range disclosed. This desired gradient of damage resulting in a gradient of etching rates

teaches away from formation of penetrating particle tracks capable of discrete etching guided by the particle tracks.

Zandveld does not inherently teach etching guided by particle tracks because Zandveld teaches an etching process "which is desired to obtain a sufficient difference in etching rate between the surface layer and the remaining part of the oxide layer 3." (col. 4:2-4). "As a result of the faster etching along the surface of the layer 3, the layer 3 at the edge of the etched-away part shows a transition region 9 with a thickness increasing towards the exterior, . . ." (col. 4:54-57). This difference in etching rates to form a bevel edge is a salient feature of Zandveld.

The formation of particle tracks capable of discrete etching and the subsequent etching guided by the particle tracks in the layer would not form the desired bevel edge and would likely render Zandveld inoperable as a p-n junction. Zandveld does not teach etching guided by particle tracks because it is contrary to the desired transition range caused by differences in etching rates through the layer.

The Applicant also submits that Claims 1, 28, and 55 as amended and claims depending from these independent claims are not obvious under 35 U.S.C. §103 over Zandveld because a *prima facie* case showing that the teachings of Zandveld suggested or motivated a modification that results in the Applicant's claimed invention or that Zandveld teaches or suggests all the claim limitations cannot be established.

"To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on Applicant's disclosure." *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991) MPEP 2142.

"To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985) MPEP 2142.

(c) Claims 1, 28, 55 are not unpatentable over Zandveld under 35 USC § 103 because Zandveld does not suggest or motivate modifications that would result in the Applicant's claimed invention.

The teaching of Zandveld does not suggest or motivate the formation of particle tracks capable of discreet etching guided by the particle tracks to fabricate a semiconductor device. In Zandveld, a difference in etching rates through the wafer is desired and a limited range of energy for the particle beam (20keV to 30 keV) is specified to achieve that result. (col. 3: 65-67). This range of energy is disclosed to produce a limited depth of penetration of the energy beam into the substrate (approximately .03 microns). (col. 4:4-8). Zandveld would not motivate higher energy levels because the subsequent penetration of the energy beam would be greater than desired and any formation of particle tracks capable of discrete etching would not provide the difference in etching rates desired in Zandveld.

Zandveld further teaches an etching process "which is desired to obtain a sufficient difference in etching rate between the surface layer and the remaining part of the oxide layer 3." (col. 4:2-4). "As a result of the faster etching along the surface of the layer 3, the layer 3 at the edge of the etched-away part shows a transition region 9 with a thickness increasing towards the exterior, . . ." (col. 4:54-57). This difference in etching rates to form a bevel edge is a salient feature of Zandveld. Zandveld does not suggest or motivate a substantially uniform etching rate along a particle track or through the substrate. Etching along particle tracks in the layer in Zandveld would not be expected to result in a "transition region 9 with a thickness increasing towards the

exterior," and would probably render Zandveld inoperable as a p-n junction. There is a patentable difference between the "structure damage obtained in the surface layer" in Zandveld, and the particle tracks capable of discrete etching for high aspect ratio nanomachining claimed in the present invention.

Note that Zandveld does teach an ion beam with energy as high as 320 keV for ion implantation of a donor impurity into the second mask layer and semiconductor body (col. 4:31-43). The region that receives this ion implantation, however, is not subject to etching and, in fact, any radiation damage in the region must then be repaired. See col. 4:63-68 where Zandveld states: "The photoresist layer 5 is then removed and the zone 8 is preferably annealed at approximately 900 degree. C in dry nitrogen for approximately 30 minutes so as to make the phosphorus ions active and to recover damage of radiation." Therefore, there would exist no incentive for increasing the energy of the ion beam for creating penetrating particle tracks in the region which would create severe, possibly irreparable damage to the wafer, with regard to the intent of fabricating semiconductor electronic devices.

(d) Claims 1, 28, 55 are patentable over Zandveld under 35 USC § 103 because Zandveld does not suggest or motivate all the claim limitations in the Applicant's invention.

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be suggested or motivated by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974). MPEP 2143.03. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985) MPEP 2142.

The Examiner contends the subject matter, "(claimed irradiating the wafer surface with a charged particle beam of suitable energy) and this would form claimed

particle tracks;" is expressly or impliedly present in Zandveld. However, Zandveld does not teach, motivate or suggest formation of particle tracks as previously discussed. Further, Zandveld does not expressly describe or mention particle tracks.

The Examiner must provide rationale or evidence tending to show inherency. "The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' " *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999) (citations omitted) MPEP 2112.

The Examiner has not provided rationale or evidence that irradiation of a wafer surface with a charged particle beam necessarily "forms particle tracks," or evidence that the formation of particle tracks is present in Zandveld.

"The rationale to support a rejection under 35 U.S.C. 103 may rely on logic and sound scientific principle." *In re Soli*, 317 F.2d 941, 137 USPQ 797 (CCPA 1963). "However, when an examiner relies on a scientific theory, evidentiary support for the existence and meaning of that theory must be provided." *In re Grose*, 592 F.2d 1161, 201 USPQ 57 (CCPA 1979). "Although the theoretical mechanism of an invention may be explained by logic and sound scientific reasoning, this fact does not support an obviousness determination unless logic and scientific reasoning would have led one of ordinary skill in the art to make the claimed invention." *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993). (MPEP 2144.02).

The Examiner has not provided any evidentiary support or scientific reasoning for a theory that irradiation of a wafer surface with a charged particle beam necessarily "forms particle tracks."

Claims 1, 28 and 55 clearly distinguish over Zandveld by the required formation of particle tracks, or as currently amended, particle tracks capable of discrete etching guided by said particle tracks. The Applicant believes the Examiner cannot establish a *prima facie* case of obviousness by Zandveld and, with the explanation provided, any potential grounds for rejection under U.S.C. 103 have been sufficiently addressed.

(e) Amended claims 29 and 63 and new claims 81 and 98 are not unpatentable over Zandveld under 35 USC § 102 or 35 USC § 103 because Zandveld does not teach the claim limitations or suggest or motivate modifications that would result in the Applicant's claimed invention.

Amended claims 29 and 63 along with new claims 81 and 98 provide an independent basis for patentability over Zandveld since they recite with particularity the need for a particle beam with an energy level of at least about 0.5 MeV to form the desired particle tracks. This energy level is far higher than anything described and would not provide the desired benefits in Zandveld as discussed supra. These claims should be considered novel over the recited art, and further, can not be considered obvious in view of the cited art.

5. Rejection of Claims under §102(e) and over Liu et. al.

The Examiner rejected Claims 1-4, 7, 8, 10, 14, 16, 18, 28-31, 34, 35, 37, 41, 43, 45, 55-57, 60, 61, 63, 67, 69, and 71 under 35 U.S.C. § 102(e) as being anticipated by Liu et al. (U.S. 6,271,127). Claims 1, 28 and 55 are independent.

In support of the rejection, the Examiner contends that Liu et al. discloses the present invention as claimed and describes:

> "A method for forming dual damascene comprising: exposing the substrate surface with and electron beam or ion implantation with suitable energy (claimed irradiating the wafer surface with a charged particle beam of suitable energy) and this would form claimed particle tracks with a

desired depth and alignment; depositing and developing a resist to form an etching pattern on the wafer (claimed depositing and removing portions of the resist layer to generate an etching pattern on the wafer); etching the wafer according to the etching pattern (col. 7, line 21-44; col. 8, line 20-30)."

In response to the rejection, the Applicant has amended independent Claims 1, 28 and 55 to more particularly claim the invention by reciting the first element to read, "irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer;" and adding a last element to read "wherein said etching is guided by said particle tracks." The Applicant respectfully submits that Liu et al. does not teach the formation of particle tracks capable of discreet etching guided by the particle tracks or the etching along particle tracks. Support for this contention is discussed below.

35 U.S.C. §102(e) reads, "A person shall be entitled to a patent unless - (e) the invention was described in - (1) an application for patent, published under section 122(b) , by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for the purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language."

"To anticipate a claim, the reference must teach every element of the claim." MPEP 2131. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

(a) Liu et al. does not expressly teach formation of particle tracks capable of discreet etching or etching guided by particle tracks.

The term particle tracks is not present in Liu et al. There is no mention of formation of particle tracks or etching along particle tracks in Liu et al.

(b) Liu et al. does not inherently teach formation of particle tracks capable of discreet etching.

"The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic." *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' " *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999).

Liu et al. does not teach the inherent formation of particle tracks but instead teaches a dual damascene process with an electron beam or ion bombardment that results in a relatively shallow radiation treatment, i.e. approximately 0.05 microns depth with an energy of 2KeV (col. 8:31-36). Liu further describes:

> "Exposure of the first low dielectric constant material layer 52 to an electron beam results in the conversion of the topmost layer of the first low dielectric constant material layer 52 into a first hard mask or etch stop 53 while rapid thermal heating associated with electron beam exposure cures the remainder of the first low dielectric constant material layer 52 so that it obtains its low dielectric constant properties." (emphasis added) (col. 6:50-57).

Accordingly, Liu et. al. teaches the surface of the material exposed to the electron beam (or ion implantation) undergoes a conversion of physical properties to create a hard mask or etch stop material. Creation of hard mask or etch stop layer with

exposure to a particle beam is inconsistent with a layer irradiated with a particle beam to produce particle tracks capable of discrete etching guided by the particle tracks. If the first etch stop layer contained such particle tracks, the first etch stop layer would be subject to deep etching along the particle tracks during the etching process of the trench, eliminating or misforming the via and likely rendering Liu et. al. inoperable. Further, the underlying layer is cured to a low dielectric-constant material through thermal heating. This does not teach formation in the material of discrete particle tracks by irradiation of the material.

The Applicant also submits that Claims 1, 28, and 55 as amended and the claims that depend from them are not obvious under 35 U.S.C. 103 over Liu et. al. because a *prima facie* case showing that the teachings of Liu et. al. suggested or motivated a modification that results in the Applicant's claimed invention or that Liu et. al. teaches or suggests all the claim limitations cannot be established.

"To establish a *prima facie* case of obviousness, there must be some suggestion or motivation, to modify the reference or to combine reference teachings. Additionally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985) MPEP 2142.

(c) Claims 1, 28, 55 are not unpatentable over Liu et. al. under 35 USC § 103 because Liu et. al. does not suggest or motivate modifications that would result in The Applicant's claimed invention.

Liu et. al. teaches a dual damascene process with an electron beam or ion bombardment that results in a relatively shallow radiation treatment, i.e. approximately 0.05 microns depth with an energy of 2KeV (col. 8:31-36). Liu further describes:

> "Exposure of the first low dielectric constant material layer 52 to an electron beam results in the conversion of the topmost layer of the first low dielectric constant material layer 52 into a first hard mask or etch stop 53 while rapid thermal heating associated with electron beam exposure cures the remainder of the first low dielectric constant material layer 52 so that it obtains its low dielectric constant properties." (emphasis added) (col. 6:50-57).

Accordingly, Liu et. al. teaches the surface of the material exposed to the electron beam (or ion implantation) undergoes a conversion of physical properties to an etch stop which is a salient feature of Liu et. al. An etch stop layer is inconsistent with a layer containing particle tracks capable of discrete etching guided by the particle tracks. If the first etch stop layer contained such particle tracks, the first etch stop layer would be subject to deep etching along the particle tracks during the etching process of the trench, eliminating or misforming the via and rendering Liu et. al. inoperable. Liu et. al. does not teach, suggest or motivate producing the claimed particle tracks. Further, the underlying layer is cured to a low dielectric-constant material through thermal heating. This does not teach or suggest formation of discrete particle tracks through the material. It would not be obvious or desirable in Liu et. al. to create particle tracks capable of discrete etching in the top most portion of a layer to produce an etch stop and to cure the remainder of the layer. As Liu et al. teaches away from a penetrating bombardment and does not provide the benefits to which the Applicant has described, these claims are novel over the recited art, and can not be considered obvious in view of the cited art.

(d) Claims 1, 28, 55 are not unpatentable over Liu et. al. under 35 USC § 103 because Liu et. al. does not suggest or motivate all the claim limitations in The Applicant's invention.

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be suggested or motivated by the prior art as discussed in subsection 3 (b) supra. MPEP 2143.03. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly

suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references." *Ex parte Clapp*, 227 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985) MPEP 2142.

The Examiner contends the subject matter, " (claimed irradiating the wafer surface with a charged particle beam of suitable energy) and this would form claimed particle tracks with a desired depth and alignment;" is expressly or impliedly present in Liu et. al. Liu et. al. does not teach, motivate or suggest formation of particle tracks. Further, Liu et. al. does not expressly describe or mention particle tracks and is silent as to alignment of a particle beam.

The Examiner must provide rationale or evidence tending to show inherency. "The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993) (reversed rejection because inherency was based on what would result due to optimization of conditions, not what was necessarily present in the prior art); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' " *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999) (citations omitted) MPEP 2112.

The Examiner has not provided a rationale or evidence that irradiation of a wafer surface with a charged particle beam necessarily "forms particle tracks with a desired depth and alignment;" or evidence that the formation of particle tracks is present in Liu et. al.

"The rationale to support a rejection under 35 U.S.C. 103 may rely on logic and sound scientific principle." *In re Soli*, 317 F.2d 941, 137 USPQ 797 (CCPA 1963). "However, when an examiner relies on a scientific theory, evidentiary support for the existence and meaning of that theory must be provided." *In re Grose*, 592 F.2d 1161, 201 USPQ 57 (CCPA 1979). "Although the theoretical mechanism of an invention may be explained by logic and sound scientific reasoning, this fact does not support an obviousness determination unless logic and scientific reasoning would have led one of ordinary skill in the art to make the claimed invention." *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993). (MPEP 2144.02)

The Examiner has not provided any evidentiary support or scientific reasoning for the theory that irradiation of a wafer surface with a charged particle beam necessarily "forms particle tracks with a desired depth and alignment."

Claims 1, 28 and 55 clearly distinguish over Liu et. al. by the required formation of particle tracks, or as currently amended, particle tracks capable of discrete etching guided by said particle tracks. The Applicant believes the Examiner cannot establish a *prima facie* case of obviousness by Liu et. al. and, with the explanation provided, any potential ground for rejection under U.S.C. 103 has been sufficiently addressed.

(e) Claims 2, 10, 29, 37, 55, 63 are not unpatentable over Liu et. al. under 35 USC § 102 or 35 USC § 103 because Liu et. al. does not teach the claim limitations or suggest or motivate modifications that would result in the Applicant's claimed invention.

The Examiner rejected claims 2, 10, 14, 29, 37, 41, 55, 63, 67 stating,

"even though Liu is silent about the charged particle beam is of predetermined collimation and at a desired direction with respect to the wafer surface, the electron beam or ion implantation would have to carry a certain collimation and at a certain direction (claimed predetermined collimation at a desired direction) with respect to the wafer surface. Claims 14, 41, 67 do not have patentable weight because it is an optional limitation."

In response to the rejection, the Applicant has carefully considered the reference and the basis of the Examiner's rejection and respectfully traverses the Examiner's rejection on those grounds.

Applicant first notes that as Claims 1, 28 and 55 appear to be allowable, Claims 2, 10, 14, 29, 37, 41, 63, and 67 which depend from these independent claims should, *a fortiori*, be allowable.

Dependent claims 2, 29, and 55 recite a limitation of irradiating a wafer with a particle beam directed to the surface of a wafer with a predetermined collimation at a desired direction. Dependent Claims 10, 37, 63 recite a limitation of placing the wafer in a particle beam in a desired direction with respect to the wafer surface. Dependent Claims 14, 41, 67 recite a limitation where the particle tracks are oriented to intercept at a substantially small point if extended.

The Examiner contends the subject matter of "a charged particle beam with a predetermined collimation and at a certain direction" is present in Liu et. al. by inherency since the reference does not expressly teach, motivate, suggest or mention the subject matter.

The Examiner must provide rationale or evidence tending to show inherency. "The fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic." *In re Rijckaert*, 9 F.3d 1531, 1534, 28 USPQ2d 1955, 1957 (Fed. Cir. 1993); *In re Oelrich*, 666 F.2d 578, 581-82, 212 USPQ 323, 326 (CCPA 1981). "To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.' " *In re Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999) (citations omitted) (MPEP 2112)

The Examiner has not provided rational or evidence that irradiation of a wafer surface with a charged particle beam necessarily results in a certain collimation and a certain direction. For example, in one circumstance, charged particle beams from multiple point sources do not necessarily carry a predetermined collimation or a certain direction with respect to a wafer surface. In another circumstance, a charged particle beam from a point source that moves relative to the surface of a wafer during irradiation does not necessarily carry a predetermined collimation or a certain direction with respect to a wafer surface. Particle tracks with a predetermined collimation (such as parallel) or a certain direction (such as perpendicular) with respect to a wafer surface have beneficial aspects in nanomachining precise structures.

In reference to Claims 14, 41 and 67, The rejection as an optional limitation is an error in view of the requirement to consider each claim "as a whole." . *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983); *Schenck v. Nortron Corp.*, 713 F.2d 782, 218 USPQ 698 (Fed. Cir. 1983) MPEP 2141.02. Particle tracks that intersect at a small point (such as a cone) have beneficial aspects in nanomachining precise structures.

Amended claims 29 and 63 along with new claims 81 and 98 provide an independent basis for patentability over Liu et. al. since they recite with particularity the need for a particle beam with an energy level of at least about 0.5 MeV to form the desired particle tracks. This is an energy level far higher than anything described in Liu et. al. and would not provide the desired benefits as discussed supra. These claims should be considered novel over the recited art, and further, can not be considered obvious in view of the cited art.

The Applicant believes the Examiner has failed to establish a *prima facie* case of obviousness by Liu et. al. and these grounds for rejection have been sufficiently addressed and overcome, and respectfully requests reconsideration and withdrawal of these grounds for rejection.

6. Rejection of Claims under U.S.C. §103(a) over Liu et al. in view of Zandveld.

The Examiner rejected Claims 9, 11, 13, 36, 38, 40, 62, 64 and 66 under 35 U.S.C. 103(a) as being unpatentable over Liu et al. as applied to Claims 1, 10, 28, 37, 55 and 63 above, and further in view of Zandveld for the following stated reason:

> "The ion implantation taught by Liu is known to one skilled in the art. Zandveld describes such ion implantation method using argon ions (col. 3, line 64-68). This would read on claimed charged particle beam is produced by removing some or all electron from neutral atoms. Method, such as using an accelerator, to produce such ions are known by one skilled in the art as shown in page 9, line 1 -2 of specification."

In response to the rejection, the Applicant notes that the referenced claims depend from Claims 1, 28 and 55, which are currently amended and patently distinct from Zandveld or Liu et. al. for the reasons explained in Subsection 4 and Subsection 5 supra.

Claims 1, 28 and 55, recite the limitation "irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer" (emphasis added).

Claims 1, 28 and 55, are not obvious over Liu et al. and in view of Zandveld, since the cited combination does not teach, suggest or motivate the limitations of Claims 1, 28 and 55, namely, formation of particle tracks capable of discrete etching guided by said particle tracks or etching guided by said particle tracks.

7. Rejection of Claims under 35 U.S.C. 103(a) over Liu et al., Zandveld and Hashimoto.

The Examiner rejected Claims 15, 17, 19-22, 42, 44, 46-49, 68, 70, 72-75 under 35 U.S.C. 103(a) as being unpatentable over Liu et al. or Zandveld as applied to Claims 1, 28, 55 above, and further in view of Hashimoto et al. (US 4,976,818). In support of the rejection, the Examiner states,

"The process of forming pattern in the photoresist is known to one skilled in the art as describes here by Hashimoto. This process include spin coating, electron beam exposure, and development in a solvent (col. 2, line 46-54).

Hashimoto also teaches using multi-layer resist system because it improves dry etch resistance and suppress the proximity effect due to reflection of electrons. The multi resist system is processed with dissolution of selective portions of the resist layer using a solvent and a plasma based etching (col. 1, line 18-31; summery; col. 2, line 39-61)."

In response to the rejection, the Applicant notes that the referenced claims depend from Claims 1, 28 and 55, which are currently amended and patently distinct from the combination of Zandveld and Liu et. al. for the reasons explained in Subsection 6 supra.

Claims 1, 28 and 55, recite the limitation "irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer" (emphasis added).

Hashimoto teaches a pattern forming method that includes the steps of electron beam writing on a photoresist layer and subsequent dry etching and etching with a solvent. Hashimoto further teaches a multi-layer resist system. Hashimoto does not teach, suggest, motivate or mention particle tracks. Further, Hashimoto does not suggest or motivate the formation of particle tracks capable of discreet etching guided by said particle tracks or etching guided by said particle tracks.

Claims 1, 28 and 55, are not obvious over Liu et al. and Zandveld, and in view of Hashimoto since the cited combination does not teach, suggest or motivate the limitations of amended Claims 1, 28 and 55, namely, the formation of particle tracks capable of discrete etching guided by said particle tracks.

8. Rejection of Claims 23-25, 50-52 and 76-78 under 35 U.S.C. 103(a).

The Examiner has rejected Claims 23-25, 50-52 and 76-78 under 35 U.S.C. 103(a) as being unpatentable over Liu as applied to Claims 1, 28, 55 above, and further in view of what the Examiner asserts is the Applicant's admitted prior art. The Examiner states,

"Referring to claims 23, 50, 76 Liu is silent about the chemistry being used for etching of the wafer. Method for etching the wafer including an etching solution or plasma is well known to one skilled in the art as described in page 13 of the specification. Therefore, at the time of the invention, using any method will be obvious in order to etch the wafer with a reasonable expectation of success. Also, the since the etched portion would have to be correspondent to that of the etched pattern, it would be the same as that of the etched pattern."

In response, The Applicant has carefully considered the basis of the Examiner's rejection, and has amended the last elements of Claims 23, 50 and 76 to more particularly read: " wherein said etched portion of said wafer has an aspect ratio substantially greater than one; and

wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern." Liu et. al. does not teach the formation or etching of particle tracks capable of discrete etching as discussed above in subsection 5. Further, Liu et al. is silent about the width and the depth of etching the via and trench in the dual damascene process. The formation of particle tracks and subsequent guided etching of particle tracks resulting in an aspect ratio of depth to width substantially greater than one is patently distinct over Liu et. al.

The references in the Applicants specification on page 13 refer specifically to methods of etching wafers which are known in the art. The Applicant's cited art does not read on, "irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer;" as required in independent Claims 1, 28, 55. The Applicant's referenced art does not read upon, "wherein said etched portion of said wafer has an aspect ratio

substantially greater than one; and wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern." as currently amended in Claims 23, 50 and 76.

In view of the subject matter of the cited art referenced above, and the amendment to Claims 23, 50 and 76 and to Claims 1, 28 and 55 to which Claims 23, 50 and 76 depend, the Applicant believes that these grounds for rejection have been sufficiently addressed and overcome, and respectfully requests reconsideration and withdrawal of these grounds for rejection.

9. Rejection of Claims 5, 6, 26, 27, 32, 33, 53, 54, 58, 59, 79 and 80 under 35 U.S.C. 103(a) as unpatentable over Liu et. al., Liu et. al./admitted prior art and further in view of Chen.

The Examiner has rejected Claims 5, 6, 26, 27, 32, 33, 53, 54, 58, 59, 79 and 80 under 35 U.S.C. 103(a) as being unpatentable over Liu or Liu /admitted prior art as applied to Claims 1, 25, 28, 52, 57, and 78 above, and further in view of Chen (U.S. 5,723,387). In support of the rejection, the Examiner states that,

"Liu doesn't describe the electroplating method for forming the Cu. Chen teaches an electroplating method for forming Cu interconnects (claim 6,7). It would have been obvious for one skilled in the art to deposit Cu in light of Chen because Chen teaches that electroplating method can form very small scale CU interconnects on semiconductor substrate."

In response to the rejection, the Applicant notes that the referenced claims depend from Claims 1, 28 and 55, which are currently amended and patently distinct from the combination Liu et. al. and prior art for the reasons explained in Subsection 7 and 8 supra.

Chen teaches an electroplating method for forming Cu interconnects. Chen does not suggest, motivate or mention formation of particle tracks. Claims 1, 28 and 55, are not obvious over Liu et al. and Liu et al/cited art and in further view of Chen since Chen does not read upon the formation particle tracks

capable of discrete etching guided by said particle tracks or etching guided by said particle tracks. Therefore the cited combination does not teach, suggest or motivate the limitations of amended Claims 1, 28 and 55. The rejected claims should be considered allowable as a result of the allowability of their antecedent independent claims 1, 28 and 55.

10. Amendment of Specification.

The Applicant noted typographical errors in the specification while preparing this response, and has corrected that error in this Amendment.

11. Amendment of Claims 1, 23, 28, 29, 50, 55, 63 and 76.

The Applicant has amended independent Claims 1, 28 and 55 to more particularly claim the invention by amending the first elements to read, "irradiating the surface of a wafer with a charged particle beam of suitable energy to form particle tracks capable of discrete etching guided by said particle tracks in said wafer;" and amending the last elements to read "etching said wafer guided by said particle tracks according to said etching pattern." Support for the amendments is provided in subsection 3 and 4 supra.

The Applicant has amended the last elements of Claims 23, 50 and 76 to more particularly claim: "wherein said etched portion of said wafer has an aspect ratio substantially greater than one; and

wherein said aspect ratio comprises the ratio of the depth of the etched particle track to the width of the smallest etched portion of said etching pattern." Support for the amendments is provided in subsection 1 and 2 supra.

Accompanying remarks have also been provided arguing the allowability of the amended Claims in view of the cited references in the Office Action.

The Applicant has retained Claims 2-22, 24-27, 29-49, 51-54, 56-75, 77-80 in their original dependent form and submits these claims should be considered allowable as a result of the allowability of their antecedent independent claims.

The Applicant has amended claims 29 and 63 to specifically recite a preferred level of energy for generating the recited particle tracks. Support for which is found in The Applicant's specification at page 9, lines 20 - 22.

12. Addition of Claims 81-123.

The Applicant has added Claims 81-123. Claims 81 - 87 recite additional limitations for independent Claim 1. Claim 88 is a new independent claim with claims 89 - 98 depending on claim 88. Claim 99 is a new independent claim for a method for fabricating a zone plate with claims 100-104 depending on claim 99. Claim 105 is an independent claim for a zone plate structure with claims 106-114 depending on claim 105. Claim 114 is an independent claim for a zone plate structure. Claim 115 is an independent claim for an improvement to a zone plate with claims 116-123 depending on claim 115. These claims recite aspects of The Applicant's invention which are not described nor inherent within the cited references.

Claim 81. Support for the energy level of "at least approximately 0.5 MeV" is found on page 9, lines 20 - 21 of the specification.

Claim 82. Support for generating parallel particle tracks is found at numerous locations, such as on page 5, line 17; page 8, lines 19 - 21; page 10 line 22 through page 11 line 9 and so forth, referring to predetermined collimation at a desired direction.

Claim 83. Support for orienting particle tracks to intercept is found at such as on page 11, line 5 - 9.

Claim 84. Support for the material of the wafer being quartz crystal, silica glass or mica is found, such as on page 9, lines 13 - 14.

Claim 85. Support for applying an etch stop material to an opposing surface of the wafer is found, such as on page 5 line 21 through page 6 line 1.

Claim 86. Support for nanomachining a zone plate having a width of about five nanometers, an aspect ratio of the depth of the etched particle track compared to the width of the smallest zone plate pattern of at least about ten, and a diameter of at least about one millimeter, is found, such as on page 7, lines 2 - 17.

Claim 87. Support for nanomachining a mica wafer as described is found, such as on page 9, lines 15 - 22.

Claim 88. This claim is similar to independent claims 1, 28, 55, with support for an aspect ratio of at least ten being found, such as on page 2, line 18.

Claim 89. Support for the e-beam resist being structurally stable during etching is found, such as on page 11, lines 10 - 17.

Claim 90. Support for the multilevel resist structure as described is found, such as on page 11, lines 10 - 17.

Claim 91. Support for applying an etch-stop material to the second side of the wafer is found, such as on page 11, lines 21 - 22.

Claim 92. Support for said pattern forming resist material being suitable for removing portions as small as five nanometers in width is found, such as on page 6, lines 10 - 17.

Claim 93. Support for said particle tracks being oriented to substantially intercept within the wafer is found, such as on page 11, line 5 - 9 (new claim 83).

Claim 94. Support for said wafer comprising a semiconductor material is found, such as in original claim 7.

Claim 95. Support for said wafer comprising an insulator material is found, such as in original claim 8.

Claim 96. Support for said wafer substantially comprising a material selected from the group consisting essentially of quartz crystal, silica glass and mica is found, such as on page 9, lines 13 - 14 (new claim 84).

Claim 97 Support for said aspect ratio being on the order of one thousand is found, such as on page 7, lines 10 - 15.

Claim 98. Support for said suitable energy to form said particle tracks being at least about five hundred thousand electron volts is found, such as on page 9, lines 20 - 22 (amended claims 29 and 63).

Claim 99. Support for a method of nanomachining to produce a zone plate is provided on page 4, lines 7-18; page 7 line 4-13 and page 14 line 7-13.

Claims 100-104. Support for the aspect ratios and dimensions claimed is provided on page 3 line 1 through page 4 line 17; page 7 line 10-12; and page 14 line 7-13.

Claim 105. Support for a zone plate structure is provided on page 4, lines 7-18, page 7 line 4-13 and page 14 line 7-13.

Claims106-110. Support for the aspect ratios and dimensions claimed is provided on page 3 line 1 through page 4 line 17; page 7 line 10-12; and page 14 line 7-13.

Claim 111-112. Support for the x-ray energy levels is provided on page 3 line 1 through page 4 line 17 and page 7 line 12-13.

Claim 113. Support for a zone plate of gold is provided at page 4 line 11.

Claim 114. Support for a zone plate structure is provided on page 4, lines 7-18; page 7 line 4-13 and page 14 line 7-13.

Claim 115. Support for an improved zone plate is provided on page 3 line 1 through page 4 line 17 and page 14 line 7-13.

Claims 116-120. Support for the aspect ratios and dimensions claimed is provided on page 3 line 1 through page 4 line 17; page 7 line 10-12; and page 14 line 7-13.

Claims 121-122. Support for the x-ray energy levels is provided on page 3 line 1 through page 4 line 17 and page 7 line 12-13.

Claim 123. Support for a zone plate of gold is provided at page 4 line 11.

13. Anticipation and obviousness considerations of new Claims 81 - 123.

With regard to anticipation and obviousness, none of the references cited by the Examiner singly or in combination teach, suggest or provide motivation or incentive to irradiate a wafer with a charged particle beam with energy suitable to form particle tracks capable of discreet etching along the particle tracks. Furthermore, a number of

these dependent claims recite additional elements which are not found, nor obvious, in view of the references cited by the Examiner singly or in combination. A few of the more glaring distinctions being detailed as follows.

Claim 81 describes the use of an energy level of 0.5 MeV for creating particle tracks prior to masking, this level of energy is not described, nor would it be desirable in the cited art as too much damage is incurred on the wafer. At least one cited reference describes the need to "repair" radiation damage, which may not be possible at the higher energy levels.

Claim 83 recites generating particle tracks to intercept one another at a small point, which provides a mechanism for etching structures such as cones and so forth in a nanostructure. Nothing of this nature is described within the cited art, which does not even describe generating particle tracks, nor does the art teach, suggest or provide motivation or incentive for performing such controlled particle track sculpting to etch nanostructures along particle tracks with an aspect ratio comparing the depth of the etched particle track to the smallest width of the etch pattern of one or greater.

Claim 85 describes the use of an etch-stop on the opposing surface of the wafer. There is no description, teaching, or suggestion in the cited art. No incentive or motivation would exist as the etching being performed therein is constrained to the first side of the wafer.

Claim 86 describes aspects of nanomachining a zone plate, according to the invention. None of these aspects are taught or suggested, and for which no motivation or incentive exists as the references are directed toward other ends.

Claim 87 describes aspects of nanomachining a mica wafer according to the invention. The cited art does not teach the method steps given, while no motivation or incentive would exist as the references are directed toward fabricating electronic structures on a semiconductor.

Claims 88-98 recite similar aspects as those above and similarly are not taught or suggested in the cited art, and for which no incentive or motivation was found in the cited art toward creating such combination of steps.

Claims 99-104 recite a method for fabricating a zone plate according to the invention. The cited art does not teach the method steps given, while no motivation or incentive would exist as the references are directed toward fabricating electronic structures on a semiconductor.

Claims 105-114 recite a zone plate fabricated according to a method of the invention. None of the references cited by the Examiner singly or in combination teach, suggest or provide motivation or incentive to fabricate a zone plate as the references are directed toward other ends.

Claims 115-123 recite an improved zone plate fabricated according to a method of the invention. None of the references cited by the Examiner singly or in combination teach, suggest or provide motivation or incentive to improve a zone plate as the references are directed toward other ends.

14. Additional Claim Fees.

An appropriate fee is enclosed for 23 additional total claims including 5 new independent claims.

15. Conclusion.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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The Applicant also respectfully requests a telephone interview with the Examiner in the event that there are questions regarding this response, or if the next action on the merits is not an allowance of all pending claims.

Date: 1/21/2004

Respectfully submitted,

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